

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74VCX16373FT

## Low-Voltage 16-Bit D-Type Latch with 3.6-V Tolerant Inputs and Outputs

The TC74VCX16373FT is a high-performance CMOS 16-bit D-type latch. Designed for use in 1.8-V, 2.5-V or 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

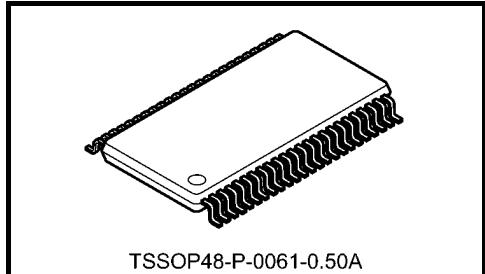
It is also designed with overvoltage tolerant inputs and outputs up to 3.6 V.

This 16-bit D-type latch is controlled by a latch enable input (LE) and an output enable input ( $\overline{OE}$ ) which are common to each byte. It can be used as two 8-bit latches or one 16-bit latch. When the  $\overline{OE}$  input is high, the outputs are in a high-impedance state.

All inputs are equipped with protection circuits against static discharge.

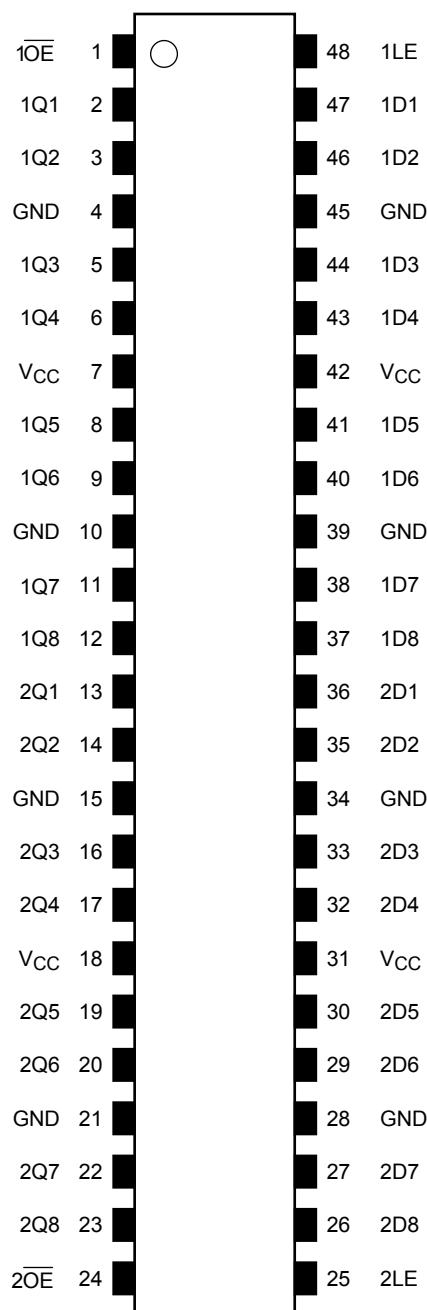
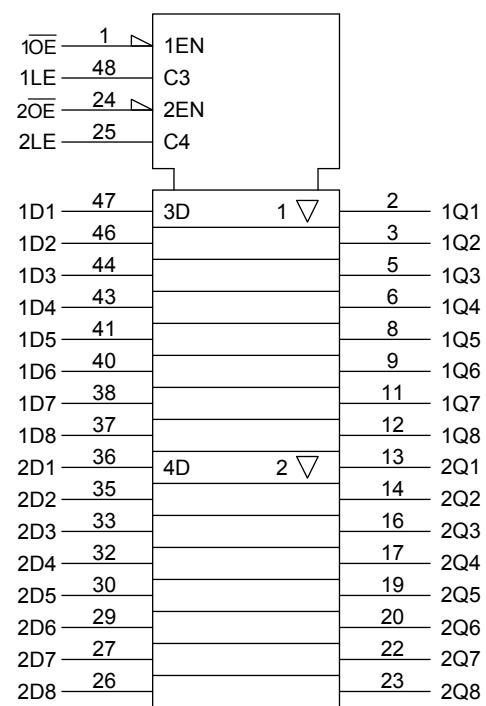
### Features

- Low-voltage operation:  $V_{CC} = 1.8$  to  $3.6$  V
- High-speed operation:  $t_{pd} = 3.0$  ns (max) ( $V_{CC} = 3.0$  to  $3.6$  V)  
  :  $t_{pd} = 3.4$  ns (max) ( $V_{CC} = 2.3$  to  $2.7$  V)  
  :  $t_{pd} = 5.7$  ns (max) ( $V_{CC} = 1.8$  V)
- Output current:  $I_{OH}/I_{OL} = \pm 24$  mA (min) ( $V_{CC} = 3.0$  V)  
  :  $I_{OH}/I_{OL} = \pm 18$  mA (min) ( $V_{CC} = 2.3$  V)  
  :  $I_{OH}/I_{OL} = \pm 6$  mA (min) ( $V_{CC} = 1.8$  V)
- Latch-up performance:  $-300$  mA
- ESD performance: Machine model  $\geq \pm 200$  V  
  Human body model  $\geq \pm 2000$  V
- Package: TSSOP
- 3.6-V tolerant function and power-down protection provided on all inputs and outputs



TSSOP48-P-0061-0.50A

Weight: 0.25 g (typ.)

**Pin Assignment (top view)****IEC Logic Symbol**

**Truth Table**

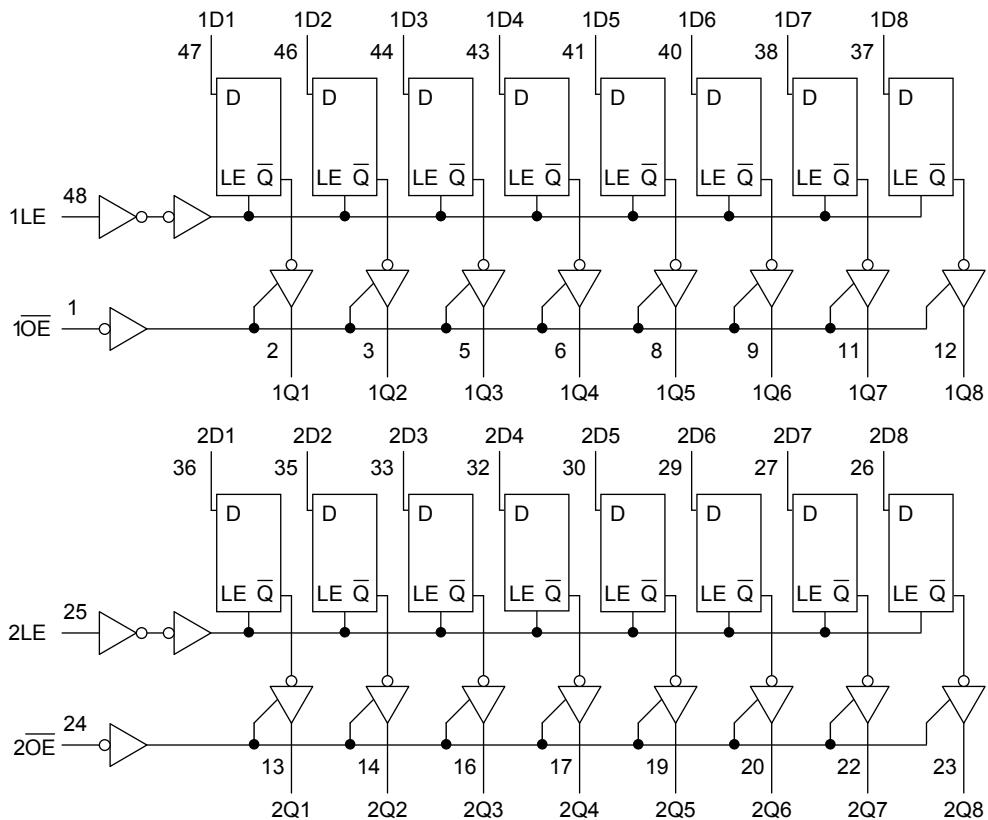
Inputs		Outputs	
$\overline{1OE}$	1LE	1D1-1D8	1Q1-1Q8
H	X	X	Z
L	L	X	Qn
L	H	L	L
L	H	H	H

Inputs		Outputs	
$\overline{2OE}$	2LE	2D1-2D8	2Q1-2Q8
H	X	X	Z
L	L	X	Qn
L	H	L	L
L	H	H	H

X: Don't care

Z: High impedance

Qn: Q outputs are latched at the time when the LE input is taken to a low logic level.

**System Diagram**

**Absolute Maximum Ratings (Note 1)**

Characteristics	Symbol	Rating	Unit
Power supply voltage	V <sub>CC</sub>	-0.5 to 4.6	V
DC input voltage	V <sub>IN</sub>	-0.5 to 4.6	V
DC output voltage	V <sub>OUT</sub>	-0.5 to 4.6 (Note 2)	V
		-0.5 to V <sub>CC</sub> + 0.5 (Note 3)	
Input diode current	I <sub>IK</sub>	-50	mA
Output diode current	I <sub>OK</sub>	±50 (Note 4)	mA
DC output current	I <sub>OUT</sub>	±50	mA
Power dissipation	P <sub>D</sub>	400	mW
DC V <sub>CC</sub> /ground current per supply pin	I <sub>CC</sub> /I <sub>GND</sub>	±100	mA
Storage temperature	T <sub>stg</sub>	-65 to 150	°C

Note 1: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc.).

Note 2: OFF state

Note 3: High or low state. I<sub>OUT</sub> absolute maximum rating must be observed.

Note 4: V<sub>OUT</sub> < GND, V<sub>OUT</sub> > V<sub>CC</sub>

**Operating Ranges (Note 1)**

Characteristics	Symbol	Rating	Unit
Power supply voltage	V <sub>CC</sub>	1.8 to 3.6	V
		1.2 to 3.6 (Note 2)	
Input voltage	V <sub>IN</sub>	-0.3 to 3.6	V
Output voltage	V <sub>OUT</sub>	0 to 3.6 (Note 3)	V
		0 to V <sub>CC</sub> (Note 4)	
Output current	I <sub>OH</sub> /I <sub>OL</sub>	±24 (Note 5)	mA
		±18 (Note 6)	
		±6 (Note 7)	
Operating temperature	T <sub>opr</sub>	-40 to 85	°C
Input rise and fall time	dt/dv	0 to 10 (Note 8)	ns/V

Note 1: The operating ranges must be maintained to ensure the normal operation of the device.

Unused inputs must be tied to either V<sub>CC</sub> or GND.

Note 2: Data retention only

Note 3: OFF state

Note 4: High or low state

Note 5: V<sub>CC</sub> = 3.0 to 3.6 V

Note 6: V<sub>CC</sub> = 2.3 to 2.7 V

Note 7: V<sub>CC</sub> = 1.8 V

Note 8: V<sub>IN</sub> = 0.8 to 2.0 V, V<sub>CC</sub> = 3.0 V

**Electrical Characteristics****DC Characteristics (Ta = -40 to 85°C, 2.7 V < V<sub>CC</sub> ≤ 3.6 V)**

Characteristics		Symbol	Test Condition		V <sub>CC</sub> (V)	Min	Max	Unit	
Input voltage	H-level		—	2.7 to 3.6					
	L-level	V <sub>IL</sub>	—	2.7 to 3.6	—	0.8	—		
Output voltage	H-level	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -100 μA	2.7 to 3.6	V <sub>CC</sub> - 0.2	—	V	
				I <sub>OH</sub> = -12 mA	2.7	2.2	—		
				I <sub>OH</sub> = -18 mA	3.0	2.4	—		
				I <sub>OH</sub> = -24 mA	3.0	2.2	—		
	L-level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 100 μA	2.7 to 3.6	—	0.2		
				I <sub>OL</sub> = 12 mA	2.7	—	0.4		
				I <sub>OL</sub> = 18 mA	3.0	—	0.4		
				I <sub>OL</sub> = 24 mA	3.0	—	0.55		
Input leakage current		I <sub>IN</sub>	V <sub>IN</sub> = 0 to 3.6 V		2.7 to 3.6	—	±5.0	μA	
3-state output OFF state current		I <sub>OZ</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V		2.7 to 3.6	—	±10.0	μA	
Power-off leakage current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 3.6 V		0	—	10.0	μA	
Quiescent supply current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V		2.7 to 3.6	—	20.0	μA	
Increase in I <sub>CC</sub> per input		ΔI <sub>CC</sub>	V <sub>IH</sub> = V <sub>CC</sub> - 0.6 V		2.7 to 3.6	—	750		

**DC Characteristics (Ta = -40 to 85°C, 2.3 V ≤ V<sub>CC</sub> ≤ 2.7 V)**

Characteristics		Symbol	Test Condition		V <sub>CC</sub> (V)	Min	Max	Unit	
Input voltage	H-level		—	2.3 to 2.7					
	L-level	V <sub>IL</sub>	—	2.3 to 2.7	—	—	0.7		
Output voltage	H-level	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -100 μA	2.3 to 2.7	V <sub>CC</sub> - 0.2	—	V	
				I <sub>OH</sub> = -6 mA	2.3	2.0	—		
				I <sub>OH</sub> = -12 mA	2.3	1.8	—		
				I <sub>OH</sub> = -18 mA	2.3	1.7	—		
	L-level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 100 μA	2.3 to 2.7	—	0.2		
				I <sub>OL</sub> = 12 mA	2.3	—	0.4		
				I <sub>OL</sub> = 18 mA	2.3	—	0.6		
				I <sub>OL</sub> = 24 mA	2.3 to 2.7	—	0.8		
Input leakage current		I <sub>IN</sub>	V <sub>IN</sub> = 0 to 3.6 V		2.3 to 2.7	—	±5.0	μA	
3-state output OFF state current		I <sub>OZ</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0 to 3.6 V		2.3 to 2.7	—	±10.0	μA	
Power-off leakage current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0 to 3.6 V		0	—	10.0	μA	
Quiescent supply current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V		2.3 to 2.7	—	20.0	μA	

DC Characteristics ( $T_a = -40$  to  $85^\circ\text{C}$ ,  $1.8 \text{ V} \leq V_{CC} < 2.3 \text{ V}$ )

Characteristics		Symbol	Test Condition		$V_{CC} (\text{V})$	Min	Max	Unit	
Input voltage	H-level	$V_{IH}$	—		1.8 to 2.3	$0.7 \times V_{CC}$	—	V	
	L-level	$V_{IL}$	—		1.8 to 2.3	—	$0.2 \times V_{CC}$		
Output voltage	H-level	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -100 \mu\text{A}$	1.8	$V_{CC} - 0.2$	—	V	
				$I_{OH} = -6 \text{ mA}$	1.8	1.4	—		
	L-level	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 100 \mu\text{A}$	1.8	—	0.2		
				$I_{OL} = 6 \text{ mA}$	1.8	—	0.3		
Input leakage current		$I_{IN}$	$V_{IN} = 0$ to $3.6 \text{ V}$		1.8	—	$\pm 5.0$	$\mu\text{A}$	
3-state output OFF state current		$I_{OZ}$	$V_{IN} = V_{IH}$ or $V_{IL}$ $V_{OUT} = 0$ to $3.6 \text{ V}$		1.8	—	$\pm 10.0$	$\mu\text{A}$	
Power-off leakage current		$I_{OFF}$	$V_{IN}, V_{OUT} = 0$ to $3.6 \text{ V}$		0	—	10.0	$\mu\text{A}$	
Quiescent supply current		$I_{CC}$	$V_{IN} = V_{CC}$ or GND $V_{CC} \leq (V_{IN}, V_{OUT}) \leq 3.6 \text{ V}$		1.8	—	20.0	$\mu\text{A}$	
					1.8	—	$\pm 20.0$		

AC Characteristics ( $T_a = -40$  to  $85^\circ\text{C}$ , input:  $t_r = t_f = 2.0$  ns,  $C_L = 30$  pF,  $R_L = 500 \Omega$ ) (Note 1)

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Min	Max	Unit
			1.8			
Propagation delay time (D-Q)	$t_{pLH}$ $t_{pHL}$	Figure 1, Figure 2	1.8	1.5	5.7	ns
			$2.5 \pm 0.2$	1.0	3.4	
			$3.3 \pm 0.3$	0.8	3.0	
Propagation delay time (LE-Q)	$t_{pLH}$ $t_{pHL}$	Figure 1, Figure 2	1.8	1.5	6.0	ns
			$2.5 \pm 0.2$	1.0	3.9	
			$3.3 \pm 0.3$	0.8	3.0	
3-state output enable time	$t_{pZL}$ $t_{pZH}$	Figure 1, Figure 3	1.8	1.5	7.0	ns
			$2.5 \pm 0.2$	1.0	4.6	
			$3.3 \pm 0.3$	0.8	3.5	
3-state output disable time	$t_{pLZ}$ $t_{pHZ}$	Figure 1, Figure 3	1.8	1.5	5.0	ns
			$2.5 \pm 0.2$	1.0	3.8	
			$3.3 \pm 0.3$	0.8	3.5	
Minimum pulse width (LE)	$t_w$ (H)	Figure 1, Figure 2	1.8	3.0	—	ns
			$2.5 \pm 0.2$	1.5	—	
			$3.3 \pm 0.3$	1.5	—	
Minimum setup time	$t_s$	Figure 1, Figure 2	1.8	2.5	—	ns
			$2.5 \pm 0.2$	1.5	—	
			$3.3 \pm 0.3$	1.5	—	
Minimum hold time	$t_h$	Figure 1, Figure 2	1.8	1.0	—	ns
			$2.5 \pm 0.2$	1.0	—	
			$3.3 \pm 0.3$	1.0	—	
Output to output skew	$t_{osLH}$ $t_{osHL}$	(Note 2)	1.8	—	0.5	ns
			$2.5 \pm 0.2$	—	0.5	
			$3.3 \pm 0.3$	—	0.5	

Note 1: For  $C_L = 50$  pF, add approximately 300 ps to the AC maximum specification.

Note 2: Parameter guaranteed by design.

$$(t_{osLH} = |t_{pLHm} - t_{pLHn}|, t_{osHL} = |t_{pHLm} - t_{pHLn}|)$$

**Dynamic Switching Characteristics (Ta = 25°C, input: t<sub>r</sub> = t<sub>f</sub> = 2.0 ns, C<sub>L</sub> = 30 pF)**

Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	Typ.	Unit
Quiet output maximum dynamic V <sub>OOL</sub>	V <sub>OOLP</sub>	V <sub>IH</sub> = 1.8 V, V <sub>IL</sub> = 0 V (Note)	1.8	0.25	V
		V <sub>IH</sub> = 2.5 V, V <sub>IL</sub> = 0 V (Note)	2.5	0.6	
		V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V (Note)	3.3	0.8	
Quiet output minimum dynamic V <sub>OOL</sub>	V <sub>OOLV</sub>	V <sub>IH</sub> = 1.8 V, V <sub>IL</sub> = 0 V (Note)	1.8	-0.25	V
		V <sub>IH</sub> = 2.5 V, V <sub>IL</sub> = 0 V (Note)	2.5	-0.6	
		V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V (Note)	3.3	-0.8	
Quiet output minimum dynamic V <sub>OIH</sub>	V <sub>OIHV</sub>	V <sub>IH</sub> = 1.8 V, V <sub>IL</sub> = 0 V (Note)	1.8	1.5	V
		V <sub>IH</sub> = 2.5 V, V <sub>IL</sub> = 0 V (Note)	2.5	1.9	
		V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V (Note)	3.3	2.2	

Note: Parameter guaranteed by design.

**Capacitive Characteristics (Ta = 25°C)**

Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	Typ.	Unit
Input capacitance	C <sub>IN</sub>	—	1.8, 2.5, 3.3	6	pF
Output capacitance	C <sub>O</sub>	—	1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	C <sub>PD</sub>	f <sub>IN</sub> = 10 MHz (Note)	1.8, 2.5, 3.3	20	pF

Note: CPD is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation:

$$I_{CC} (\text{opr}) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/16 \text{ (per bit)}$$

## AC Test Circuit

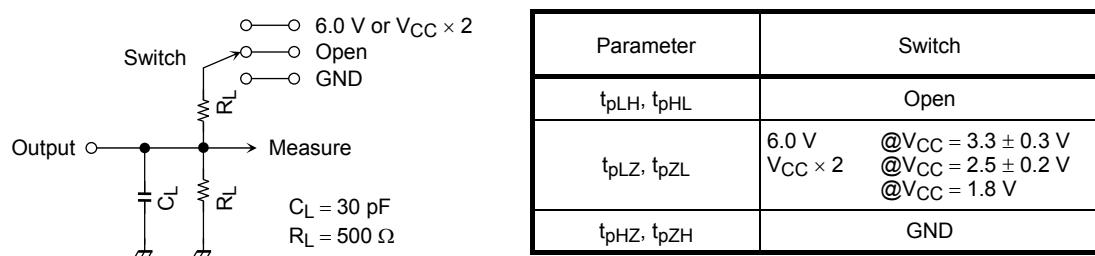
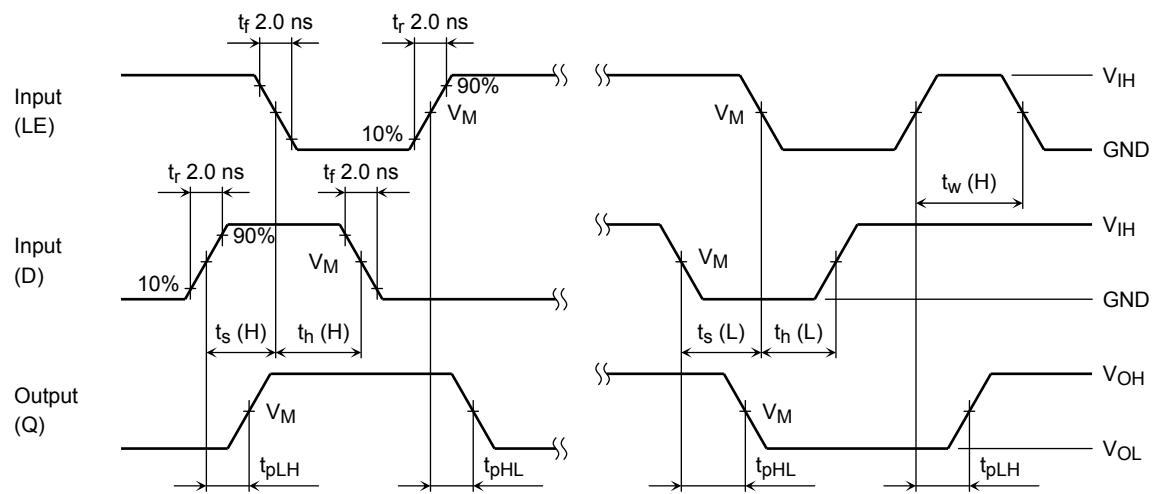
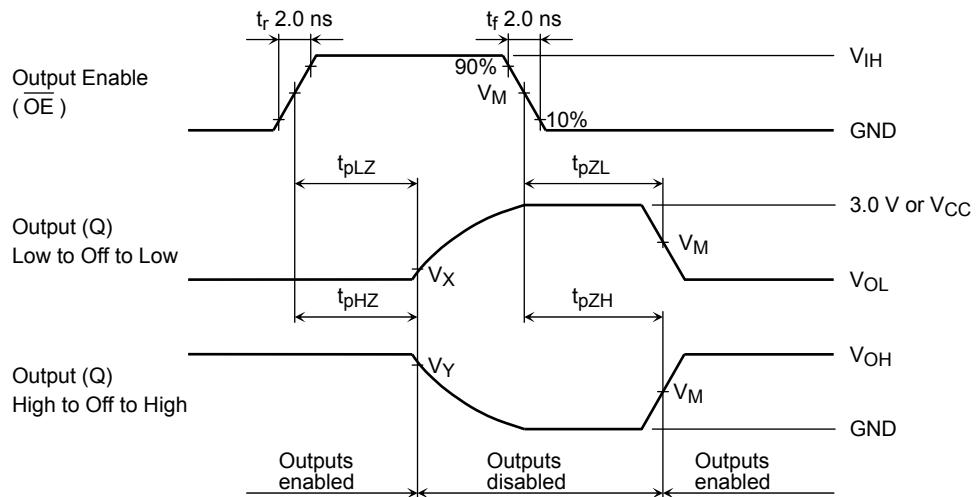


Figure 1

## AC Waveform

Figure 2  $t_{pLH}, t_{pHL}, t_w, t_s, t_h$



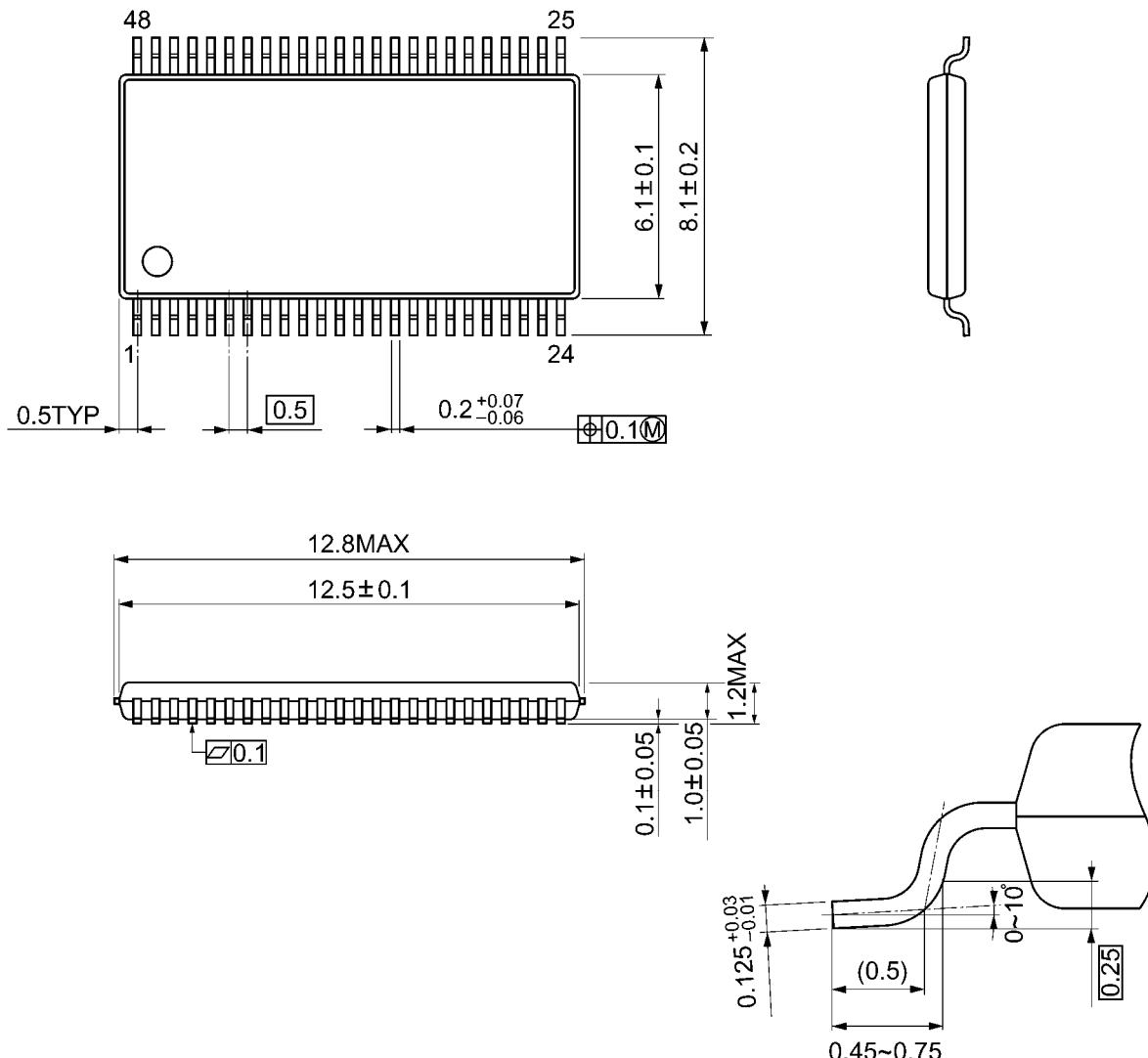
**Figure 3**  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$

Symbol	$V_{CC}$		
	$3.3 \pm 0.3$ V	$2.5 \pm 0.2$ V	1.8 V
$V_{IH}$	2.7 V	$V_{CC}$	$V_{CC}$
$V_M$	1.5 V	$V_{CC}/2$	$V_{CC}/2$
$V_X$	$V_{OL} + 0.3$ V	$V_{OL} + 0.15$ V	$V_{OL} + 0.15$ V
$V_Y$	$V_{OH} - 0.3$ V	$V_{OH} - 0.15$ V	$V_{OH} - 0.15$ V

**Package Dimensions**

TSSOP48-P-0061-0.50A

Unit: mm



Weight: 0.25 g (typ.)

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